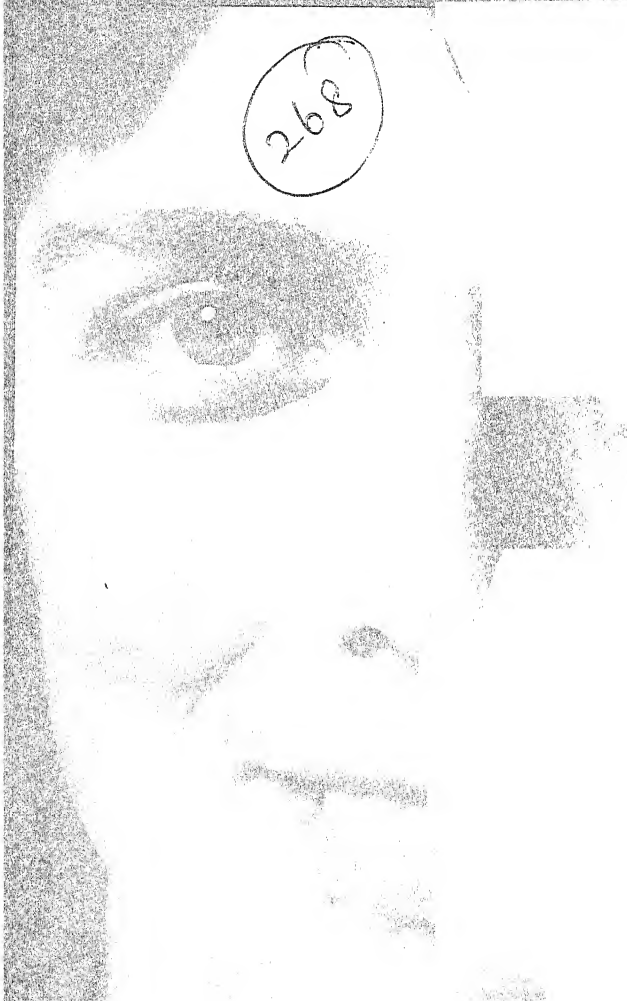


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# Diabetes and your eyes

U.S. DEPARTMENT OF  
HEALTH AND HUMAN SERVICES  
Public Health Service  
National Institutes of Health

268



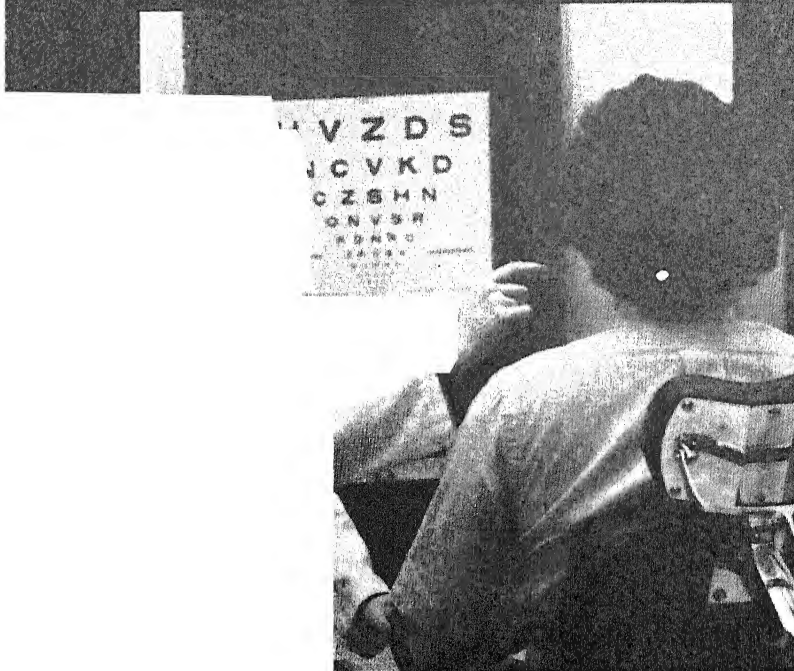


# **Diabetes and your eyes**

**Prepared by the  
Office of Scientific Reporting  
National Eye Institute**

**U.S. DEPARTMENT OF  
HEALTH AND HUMAN SERVICES  
Public Health Service  
National Institutes of Health  
Bethesda, Maryland 20205**

## Visual Acuity Test



part of the eye examination that diabetics should

## **An Important Message For People With Diabetes**

If you are among the 10 million people in the United States who have diabetes—or if someone close to you has this disease—you should know that diabetes can affect the eyes. The most common eye problem associated with diabetes is damage to the blood vessels in the retina—the tissue at the back of the eye that transmits visual messages via the optic nerve to the brain. This condition, called diabetic retinopathy, causes varying degrees of visual loss, including blindness.

Fortunately, there are new ways to prevent or lessen the damage caused by diabetic retinopathy. A laser treatment called “photocoagulation” can reduce the risk of severe visual loss from the disease, and a surgical procedure called “vitrectomy” can save useful vision in some persons whose eyes are already severely affected by diabetes.

Approximately 40 percent of this country’s 10 million diabetics show at least mild signs of diabetic retinopathy, and about 3 percent have suffered severe visual loss because of it. Generally, the longer you have had diabetes, the greater your chances of developing diabetic retinopathy and visual loss.

Diabetic retinopathy usually causes no symptoms in its early stages. This means that people with diabetes have no way of knowing whether they are in danger of losing their eyesight. The early signs of diabetic retinopathy can be detected only by a physician or eye care specialist trained to recognize the disease.

So if you have diabetes, you should have a professional eye examination as soon as your disease is diagnosed, and once a year thereafter. Annual eye examinations are especially important if you have had diabetes 5 years or longer.

This booklet will explain how diabetes affects the eyes, and how the risk of visual loss from diabetic retinopathy can be reduced. A Glossary of Terms is provided on page 12.

## About Diabetes

Diabetes is a complex disorder in which the body is unable to use properly certain food elements, especially starches and sugars. Normally, the body's digestive juices convert starches and sugars into glucose, a simple sugar, which circulates in the blood. The hormone insulin allows the body to convert glucose into energy needed for everyday activities or store it for later use.

Insulin is produced by the pancreas gland. In someone with diabetes, however, either the pancreas does not produce enough insulin, or the body does not properly utilize the insulin that is produced. As a result, excess glucose collects in the blood and tissues and overflows into the urine.

Daily injections of insulin, plus a special diet that controls starch, sugar, and calorie intake, can help prevent the build-up of glucose and control insulin-dependent diabetes. An estimated 400,000 Americans suffer from this form of the disease.

Noninsulin-dependent diabetes affects the remainder of the 10 million diabetic persons in this country, about half of whom are unaware that they have the disease. This more common type of diabetes can be managed with a controlled diet, regular exercise and, in some cases, oral medication.

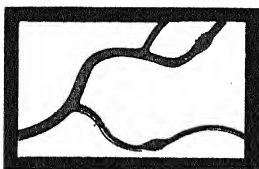
Both forms of diabetes can cause long-term, serious damage to virtually every tissue in the body, particularly the tiny blood vessels of the nerves, kidneys, and eyes.

## About Diabetic Retinopathy

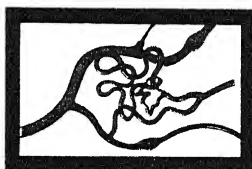
No one knows exactly how diabetes causes damage to the eyes. It is known, however, that diabetics are more likely than people who are free of the disease to develop a number of visual disorders. This is especially true for people who have had diabetes 5 years or longer. One of the milder, often temporary, effects of diabetes is a change in the focusing power of the eye. Eyeglasses or contact lenses might suddenly seem to be “too strong” or “too weak.” Indeed, such an abrupt change in vision—when no other cause can be found—may be the first sign of diabetes.

Diabetes also may cause several other eye problems, including cataract and a type of glaucoma. (See Glossary of Terms.) But the most important and most common cause of visual impairment in diabetics is diabetic retinopathy.

Diabetic retinopathy is a deterioration of the small blood vessels that nourish the retina. When these blood vessels become damaged by diabetes, they can no longer supply all the oxygen and nutrients the retina needs to remain healthy.



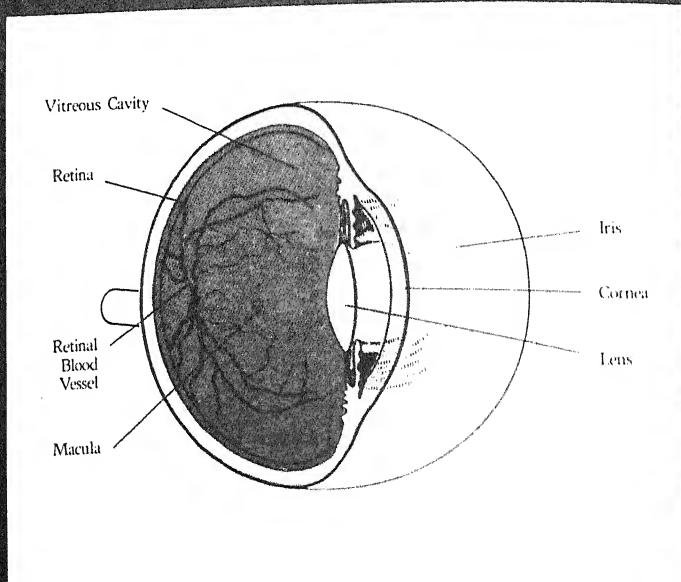
**Background or Early  
Diabetic Retinopathy**



**Proliferative or Advanced  
Diabetic Retinopathy**

Diabetic retinopathy affects people in different ways. It begins as a mild condition known as “background” retinopathy. At this stage, the retinal blood vessels may become enlarged in places, ballooning outward and leaking fluid which can collect and cause swelling in the retina. When this fluid collects in the macula (the central part of the retina), it may cause a blurring of central vision. In about 80 percent of diabetics with retinopathy, vision is not seriously affected and the disorder never progresses beyond the background stage. Diabetic retinopathy can, however, progress to the more advanced, “proliferative” stage in which abnormal

## The Eye



new blood vessels sprout—a process known as “neovascularization”—and grow along the surface of the retina. These new blood vessels are fragile and may rupture and bleed into the vitreous humor (the clear gel that fills the center of the eye), interfering with the passage of light to the retina. Or scar tissue, which sometimes forms near the retina, may contract and pull on the retina, detaching it from the back of the eye. In either case, severe visual loss, even permanent blindness, may result.

Unfortunately, there are few early symptoms of diabetic retinopathy, particularly in the background stage, which warn that the disease is progressing, and that vision is threatened.

## **Detecting Diabetic Retinopathy**

Because the person who has diabetic retinopathy may not know it, diabetics should have an annual eye examination by a doctor trained to diagnose diseases of the retina and to determine when medical or surgical treatment is needed.

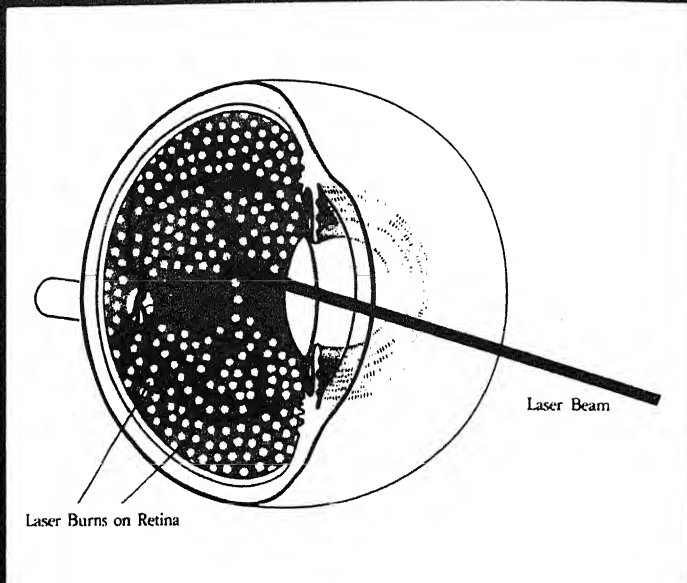
During the examination eyedrops are used which enlarge the pupil so that the retinal blood vessels at the back of the eye can be seen with an instrument called the ophthalmoscope. Although additional examination is usually not necessary, the retina can be viewed in more detail by photographing it with a special camera after a fluorescent dye is injected into the arm. As the dye passes through the blood vessels in the retina, a rapid sequence of photographs is taken which reveals whether, where, and how fast dye is leaking out of the vessels. This procedure, called fluorescein angiography, can detect changes in blood vessels associated with diabetic retinopathy.

Regular eye examinations are particularly important for people who stand a high risk of developing diabetic retinopathy and other ocular complications of diabetes. These include persons with diabetes who have had their disease 5 years or longer, and who have difficulty controlling glucose levels in the blood.

In addition, pregnancy is known to be a factor in the development or worsening of diabetic retinopathy. And there is evidence to suggest that high blood pressure and smoking may cause diabetic retinopathy to worsen.



## Laser Burns in Panretinal Photocoagulation



# Treating Diabetic Retinopathy

One of the most important research findings to benefit people with diabetic retinopathy has been the demonstration that photocoagulation can reduce the risk of visual loss from this disorder. During this treatment, powerful beams of light from a laser are aimed at many spots on the diseased retina, the effect of which is to interrupt the disease process and prevent the development of additional retinal abnormalities.

Photocoagulation was first used to treat diabetic retinopathy in the late 1950s. Research during the next decade suggested that photocoagulation might be an effective treatment for this disorder. Yet no carefully controlled study of a large group of patients had ever proved this. Therefore, in 1970 a nationwide clinical trial, the Diabetic Retinopathy Study (DRS), was begun under the sponsorship of the National Eye Institute (NEI) to determine conclusively whether photocoagulation was safe and effective for treating advanced stages of diabetic retinopathy. The study eventually included 1,758 patients at 15 medical centers in the United States, and was the largest clinical trial in the history of eye research.

The DRS showed that photocoagulation treatment, as it was used in the study, can reduce by 60 percent the chance that people with advanced retinopathy will suffer "severe visual loss." Severe visual loss is defined as a long-term loss of the ability to read the largest letter on the eye chart from a distance of 5 feet.

Further analysis of DRS data has shown that an individual's chance of experiencing severe visual loss from diabetic retinopathy is directly related to the presence or absence of certain changes in the retina. These changes or risk factors can be identified by looking into the eye through an ophthalmoscope. The presence or absence of such risk factors can help an ophthalmologist decide which diabetic patients to consider for photocoagulation, and when to begin treatment.

It is important to understand that photocoagulation may not be appropriate for everybody. It cannot, for example, be used when bleeding inside the eye makes it difficult or impossible for the doctor to see the areas of the retina that need treatment. Furthermore, in some patients there may be certain unwanted side effects of laser treatment, including

some loss of central and side vision. Thus, the potential benefits of photocoagulation must be weighed against the risks of side effects in each individual patient. Although those treated may lose some vision, nonetheless the more advanced the diabetic retinopathy, the more clearly the benefits outweigh the risks of side effects.

The benefits of treatment at less advanced stages of diabetic retinopathy are now being evaluated in a new NEI clinical trial, the Early Treatment Diabetic Retinopathy Study (ETDRS). (Medical centers participating in the study are listed on pages 15 and 16.) This clinical trial is designed to determine whether photocoagulation—used alone or in combination with a low dose of aspirin daily—can slow or stop the progression of diabetic retinopathy when used early in the course of the disease. The original Diabetic Retinopathy Study demonstrated that photocoagulation can help people with advanced diabetic retinopathy, but was not designed to show whether it could benefit people with less severe retinopathy.

Despite photocoagulation, many diabetic retinopathy patients have gone blind from massive bleeding inside the eye. Now, ophthalmologists can remove the blood and scar tissue from the center of the eye with special surgical instruments. This procedure is known as vitrectomy.

Following vitrectomy, patients can often see well enough to move around on their own. Occasionally, vision in the operated eye recovers enough for reading or driving. Because of the risk of surgical complications, ophthalmologists may wait a year before performing a vitrectomy to see if the blood inside the eye clears on its own, which it sometimes does. However, some surgeons believe that better vision might result for more patients if surgery were performed soon after severe bleeding (hemorrhage) occurs.

To explore whether it is better to perform vitrectomy promptly after hemorrhage, or better to wait a year, the NEI is supporting the Diabetic Retinopathy Vitrectomy Study (DRVS). The study also is designed to determine whether vitrectomy is effective in preventing hemorrhage and other complications in patients with very severe diabetic retinopathy but no vitreous hemorrhage. About 1,200 patients in medical centers throughout the United States have been enrolled in the DRVS and are now being studied.

In addition to these clinical trials, the National Eye Institute is supporting an extensive program of research on the causes, detection, and treatment of diabetic retinopathy, including basic studies on how diabetes affects the eye. In 1980, the National Eye Institute spent more than \$16 million for research on these important problems.

## **A Word About Self-Care**

While scientists seek new ways to prevent and treat diabetic retinopathy, people with diabetes can work to maintain their health and keep their disease under control. Although the precise relationship between glucose levels and the development of diabetic complications is not fully understood, many physicians who treat diabetes believe that good control of glucose levels will lessen or delay complications, including those affecting vision. Here are some health practices which may benefit diabetic individuals:

- take insulin and other medications as prescribed by a physician;
- inform each physician of medication prescribed by other doctors;
- follow a controlled diet recommended by your doctor;
- maintain normal body weight;
- do not smoke;
- exercise regularly;
- have blood pressure checked periodically;
- have an annual eye examination.

The American Diabetes Association recommends that diabetics be seen by an ophthalmologist as soon as their disease is diagnosed. Their eyes should be examined once a year thereafter, although individuals with significant diabetic retinopathy should be seen more frequently. Generally, the longer a person has had diabetes, the more critical annual eye examinations become.

## Glossary Of Terms

**Cataract:** a clouding of the lens of the eye. Cataract interferes with vision by blocking the passage of light rays to the back of the eye. It is treated by surgical removal of the opaque lens.

**Diabetic Retinopathy:** a diabetes-caused disorder of the blood vessels in the retinal tissue at the back of the eye. Diabetic retinopathy is one of the leading causes of blindness in the United States.

**Diabetes:** a disease in which the body cannot properly utilize certain nutrients from food and cannot efficiently convert them into the energy necessary for daily activity.

**Fluorescein Angiography:** a means of photographing the flow of blood in the retinal vessels of the human eye by tracing the progress of an injected fluorescein dye.

**Glaucoma:** an eye disease associated with increased pressure within the eye. Glaucoma can damage the optic nerve and cause impaired vision and blindness.

**Glucose:** a simple sugar which is formed when digestive juices and other body chemicals process the sugars and starches (carbohydrates) in food. Glucose is the body's main source of energy.

**Insulin:** a hormone produced by the pancreas gland. Insulin regulates the amount of glucose that circulates in the blood.

**Laser:** a device which generates an intense beam of light energy. Laser is an acronym for light amplification by stimulated emission of radiation. Various types of lasers are used in eye surgery.

**Macula:** the area near the center of the retina that is responsible for fine or reading vision. A common complication of diabetic retinopathy is swelling (edema) in the macular area which distorts vision.

**Neovascularization:** growth of abnormal new blood vessels along the surface of the retina. Neovascularization occurs in advanced stages of diabetic retinopathy.

**Ophthalmoscope:** an instrument with a perforated mirror and light used to examine the interior of the eye.

**Pancreas:** one of the body's major glands. An important function of the pancreas is to produce insulin.

**Photocoagulation:** a surgical procedure using an intense beam of light to seal off or destroy leaking blood vessels and damaged tissue in the retina. Photocoagulation is used in the treatment of diabetic retinopathy.

**Retina:** the light-sensitive tissue that lines the inside of the back of the eye. The retina receives visual images and sends messages via the optic nerve, to the brain where "seeing" actually takes place.

**Vitrectomy:** surgical removal of the vitreous, the normally transparent gel that fills the center of the eye. When a diseased vitreous becomes clouded by blood and scar tissue, it can be removed with a special instrument which then replaces the vitreous with a clear solution.

## Where To Find Help

If you know you have diabetes, you are probably under the care of a physician who can refer you to an eye doctor for regular examinations. In addition, you can get a referral from your local medical society or bureau, or from a hospital, a medical school, or a diabetes clinic at a major medical center.

Names of diabetic retinopathy experts also can be obtained from centers cooperating in the Early Treatment Diabetic Retinopathy Study which is supported by the National Eye Institute. The centers are listed on pages 15 and 16.

Several government and private organizations can provide additional information on diabetes and diabetic retinopathy. The names and addresses of some of them are listed below. Also listed are sources of help and information for people with impaired vision, whether caused by diabetic retinopathy or some other eye disease.

\*American Diabetes  
Association  
2 Park Avenue  
New York, New York  
10016  
(212) 683-7444

\*National Society to Prevent  
Blindness  
79 Madison Avenue  
New York, New York  
10016  
(212) 684-3505

\*Juvenile Diabetes  
Foundation  
23 East 26th Street,  
4th Floor  
New York, New York  
10010  
(212) 889-7575

National Eye Institute  
National Institutes of  
Health  
Building 31, Room 6A32  
Bethesda, Maryland 20205  
(301) 496-5248

National Diabetes Informa-  
tion Clearinghouse  
805 - 15th Street, N.W.,  
Suite 500  
Washington, D.C. 20005  
(202) 842-7630

National Institute of  
Arthritis, Diabetes, and  
Digestive and Kidney  
Diseases  
National Institutes of  
Health  
Building 31, Room 9A04  
Bethesda, Maryland 20205  
(301) 496-3583

American Foundation for  
the Blind  
15 West 16th Street  
New York, New York  
10011  
(212) 620-2000

\*Check your telephone directory  
for local chapters or affiliates.

# Centers Participating in The Early Treatment Diabetic Retinopathy Study (ETDRS)

## California

Estelle Doheny Eye Foundation  
School of Medicine  
University of Southern California  
1355 San Pablo Avenue  
Los Angeles 90033  
*Principal Investigator:*  
John Hodgkinson, M.D.  
Telephone: (213) 226-5227

Jules Stein Eye Institute  
Center for the Health Sciences  
UCLA Medical Center  
Room 3-114  
800 Westwood Plaza  
Los Angeles 90024  
*Principal Investigator:*  
Stanley Kopelow, M.D.  
Telephone: (213) 206-6093

Zweng Memorial Retinal  
Research Foundation  
1225 Crane Street  
Menlo Park 94025  
*Principal Investigators:*  
Hunter Little, M.D.  
Robert Jack, M.D.  
Telephone: (415) 323-0231

Department of Ophthalmology  
Pacific Medical Center  
2340 Clay Street  
San Francisco 94115  
*Principal Investigator:*  
Everett Ai, M.D.  
Telephone: (415) 563-4321

## Florida

Bascom Palmer Eye Institute  
Department of Ophthalmology  
School of Medicine  
University of Miami  
900 N.W. 17th Street  
Miami 33136  
*Principal Investigator:*  
Harry Flynn, M.D.  
Telephone: (305) 326-6118

## Illinois

University of Illinois  
at the Medical Center  
Room 2, 224  
Illinois Eye and Ear Infirmary  
1855 West Taylor Street  
Chicago 60612  
*Principal Investigator:*  
Jay Terry Ernest, M.D.  
Telephone: (312) 996-7843

## Illinois cont'd

Retinal Vascular Service  
Ingalls Memorial Hospital  
One Ingalls Drive  
Harvey 60426  
*Principal Investigator:*  
David Orth, M.D.  
Telephone: (312) 333-2300

## Louisiana

LSU Eye Center  
136 South Roman Street  
New Orleans 70112  
*Principal Investigator:*  
Rudolph Franklin, M.D.  
Telephone: (504) 568-6766

## Maryland

The Wilmer Ophthalmological  
Institute  
School of Medicine  
Johns Hopkins University  
Maumenee Room 113  
600 N. Wolfe Street  
Baltimore 21205  
*Principal Investigator:*  
Robert Murphy, M.D.  
Telephone: (301) 955-2840

## Massachusetts

Joslin Diabetes Foundation  
One Joslin Place  
Boston 02215  
*Principal Investigator:*  
Lloyd Aiello, M.D.  
Telephone: (617) 732-2554

Eye Research Institute of Retina  
Foundation/Retina Associates, Inc.  
100 Charles River Plaza  
Boston 02114  
*Principal Investigators:*  
Sheldon Buzney, M.D.  
J. Wallace McMeel, M.D.  
Telephone: (617) 523-7810

## Michigan

Kresge Eye Institute  
School of Medicine  
Wayne State University  
3994 John R. Street  
Detroit 48201  
*Principal Investigator:*  
Robert Frank, M.D.  
Telephone: (313) 577-1320



## ETDRS Centers Continued

### Michigan cont'd

Associated Retinal  
Consultants, P.C.  
3535 West 13 Mile Road  
Suite 507  
Royal Oak 48072  
*Principal Investigator:*  
Raymond Margherio, M.D.  
Telephone: (313) 288-2280

### Minnesota

Department of Ophthalmology  
Medical School  
University of Minnesota  
Box 493  
Mayo Memorial Building  
Minneapolis 55455  
*Principal Investigator:*  
William Knoblock, M.D.  
Telephone: (612) 373-8425

### New York

Department of Ophthalmology  
Retina Division—K328  
Albany Medical College  
47 New Scotland Avenue  
Albany 12208  
*Principal Investigator:*  
Aaron Kassoff, M.D.  
Telephone: (518) 445-5246

### Oregon

Devers Eye Clinic  
Good Samaritan Hospital  
and Medical Center  
1200 Northwest 23rd Avenue  
Portland 97210  
*Principal Investigator:*  
Michael Klein, M.D.  
Telephone: (503) 229-7459

### Pennsylvania

Retina Service  
Wills Eye Hospital  
9th and Walnut Streets  
Philadelphia 19107  
*Principal Investigators:*  
William Tasman, M.D.  
William Benson, M.D.  
Telephone: (215) 247-3115

### Puerto Rico

University of Puerto Rico  
Medical Science Campus  
University of Puerto Rico—  
Rio Piedras  
Room A904, GPO Box 5067  
San Juan 00936  
*Principal Investigator:*  
Jose Berrocal, M.D.  
Telephone: (809) 725-9315

### Texas

Hermann Eye Center  
University of Texas Medical  
School at Houston  
1203 Ross Sterling  
Houston 77030  
*Principal Investigator:*  
Charles Garcia, M.D.  
Telephone: (713) 792-7677

### Utah

Holy Cross Hospital  
1045 East 1st South  
Salt Lake City 84102  
*Principal Investigator:*  
F. Tempel Riekhof, M.D.  
Telephone: (801) 532-7406

### Washington

Department of Ophthalmology  
RJ-10  
RR 801 HSB  
University of Washington  
Seattle 98195  
*Principal Investigators:*  
James Kinyoun, M.D.  
Robert Kalina, M.D.  
Telephone: (206) 543-2599

### Wisconsin

Department of Ophthalmology  
Medical School  
University of Wisconsin  
F4 Clinical Science Center  
600 Highland Avenue  
Madison 53792  
*Principal Investigators:*  
George Bresnick, M.D.  
Frank Myers, M.D.  
Telephone: (608) 263-7169

Department of Ophthalmology  
Box 160  
Medical College of Wisconsin  
8700 West Wisconsin Avenue  
Milwaukee 53226  
*Principal Investigator:*  
Frederick Reeser, M.D.  
Telephone: (414) 475-0701

